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ABSTRACT

An adequate theory of phonology should be able to explain the process of adaptation of foreign words into the native language, as well as to account for their nativized phonological and phonetic representations. The paper acknowledges the deficiencies of the "phonetic approximation" and the "phonemic approximation" hypotheses in meeting this end, and discusses the shortcomings of Hyman's (1970) generative phonology model. The model presented here is derived from Stampe's (1968, 1969) natural phonology theory, and hypothesizes that incoming foreign segments will be inserted into the lexicon without change unless they are inadmissible underlying segments, in which case they will be analyzed by the native rules until some admissible representation is obtained. If a segment cannot be analyzed as an admissible form in the native system, it will be represented in the lexicon as it is and eventually will be restructured by the dominant native rules. Within this paradigm, certain English loans in Japanese are examined, and at the same time properties of the system of Japanese phonology which are revealed in the process of borrowing are discussed. Among the areas discussed are: palatalization, vowel insertion, gemination of consonants, and glides. (DB)

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A Phonological Study of Some English Loan Words in Japanese*

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1. Principles of borrowing

Loan words sometimes bring into a language new sounds or new sequences of sounds, but in many cases foreign sounds are changed to conform to the native phonological system. Furthermore, the manner of nativization is quite regular. People don't simply substitute an arbitrary native segment for a foreign sound. An adequate theory of phonology has to explain the process of adaptation of foreign words, and their nativized phonological and phonetic representations.

That they cannot be explained adequately in terms of a 'phonetic approximation' hypothesis or by 'phonemic approximation' based on the theory of taxonomic phonemics was convincingly demonstrated by Hyman (1970). Hyman attempted to view the phenomena of borrowing in the light of generative phonology. Working with loan words in Nupe, a Kwa language of Central Nigeria, he proposed principles which account for his data, but do not seem adequate for borrowing processes in general. That is, there seem to be some cases where his principles allow several alternative substitutions for certain foreign segments, but without any principled way of choosing among them. Since the data suggest that the process of nativization does not allow so many alternatives, his principles need revision. In the following section I will first discuss the cases where Hyman's hypotheses result in indeterminacy and then some alternative principles which seem to account for borrowing more adequately.

1.1. Hyman's hypotheses

Hyman's principles of borrowing are:

1. Foreign sounds are perceived in terms of underlying forms. (19)
2. Foreign segments equivalent to native segments derived by rule are lexicalized as the corresponding native underlying forms. (39)

There is a partial contradiction between these two hypotheses. If a language has phonetic sequence yz which is derived from the underlying xz by a rule $x \rightarrow y / __z$ and it also has an underlyin,

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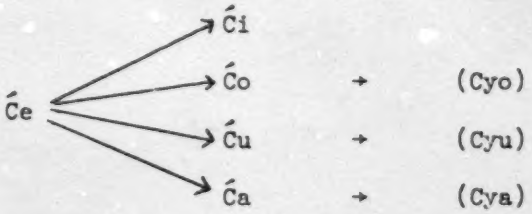
sequence yz, does the language lexicalize the borrowed sequence yz as xz or yz? When the opposition of underlying x and y completely neutralizes in the environment __z, the sequence will be lexicalized as yz according to his first principle, but as xz according to his second principle. Hyman gives no resolving principle.

Secondly, his principles cannot give a sufficient explanation for why Nupe speakers create an epenthetic vowel in borrowing a consonant cluster inadmissible in the native system. He says it is because the morpheme structure of Nupe is (V)CV(CV). But this doesn't tell why Nupe speakers insert a vowel rather than simplify the consonant cluster. Either process would change an inadmissible cluster to conform to the native (V)CV(CV) pattern.

Finally I would like to consider his third principle:

> 3. When a foreign segment appears in an environment in which the equivalent native derived segment does not appear, then the form of the incoming foreign word is modified so that the structural description of that rule is met and the segment in question is then derived in the appropriate environment. (40)

It means that when a language which has a rule x → y / __z borrows a sequence yw where w is distinct from z, w is changed to z so that y is derived in the appropriate environment by the rule x → y / __z. This principle is too strong, because it allows more than one substitution for the segment or segments denoted by w above, and doesn't predict what will actually happen. For example, Japanese has a rule which palatalizes a consonant before the high front vowel i and the high front glide y. By this rule, there are the sequences Ći, Ćya, Ćyo and Ćyu, but no Će. There are no Ćyi or Ćye, since the glide y is deleted before the front vowels, before the palatalization rule applies. Ćya, Ćyo and Ćyu become Ća, Ćo and Ću, respectively, by the rule which deletes y after palatalized consonants. In summary, Japanese has the sequences Ći, Ća, Ćo, Cu, but no Će. Now, according to Hyman's hypothesis 3, when Japanese borrows a sequence Će, speakers would change its vowel e to some other segment, so that the palatalized consonant is derived in the appropriate environment by the palatalization rule of Japanese. What is unclear here is how a new environment will be chosen when there are several alternatives. In this case all the following substitutions are possible.



It seems that he tacitly assumes that the segment closest to the original one (in distinctive features) is chosen in such a case.

i and o are closer to e than u and a, because they differ from e by only one feature, while u and a differ from e by two, so that i or o would be chosen.[1] But still there is no way to choose one of them systematically. Furthermore, Japanese data show that the change of environments indicated by principle 3 is very rare. In the case of Če, the consonant is depalatalized when nativized. But the vowel insertion in Japanese observed in the borrowing of words with consonant clusters or with a word-final consonant suggests that some weaker version of the principle is necessary. The Nupe data which required Hyman to set up principle 3, on the other hand, could be explained without it, as I shall show in the following section.

1.2. Borrowing in natural phonology

I now examine borrowing based on the theory of natural phonology (Stampe 1968, 1969). It is possible to view the borrowing process as parallel to children's acquisition of phonological representations. If incoming foreign sounds are admissible underlying segments in the native phonological system they will be represented in the lexicon without change. That is, the foreign phonetic representations will be adopted as underlying forms. In this case there will be no conflict between Hyman's principles 1 and 2. In the case I cited, yz will be lexicalized as yz unless some information is available which prevents this underlying representation. If, on the other hand, some foreign sounds are underlyingly inadmissible, they will be analyzed by suitable native rules to obtain admissible representations. That is, segments will be analyzed (according to certain rules) only when they are inadmissible in the lexicon. I will refer to the operative rules, which constrain underlying representation, as 'dominant'. Suppose that the native phonological system of a language has a dominant rule $x \rightarrow y$ eliminating x from the lexicon. If it has a rule $v \rightarrow x$ / __z, dominated by the above rule and allowing a superficial x, the foreign sequence xz will be analyzed as wz, since x is an inadmissible underlying segment.[2] If wz, obtained after analysis, is still inadmissible, further analysis will be carried out until some admissible segment is obtained, provided that there is a rule available in the native system to cope with it.

If some foreign segments cannot be analyzed as admissible underlying representations in the native system, they will be registered as violations of the rules which prohibit them. Since those rules do apply to them, no hearer would ever have the chance to notice the irregular representation in the lexicon of the borrower. He will, therefore, treat them just like the native forms in learning and represent them in the lexicon without any of the irregularity observed in the borrower's lexicon.

The children who are learning a language will finally revise the innate system of rules so that admissible representations will be achieved for all the forms they hear from adults. But it seems to be very difficult for adults who have once acquired a phonological

system to revise it to comprise new segments or new sequences of segments. In many cases perception itself seems to be constrained by the native system, so that speakers perceive foreign sounds in terms of the native phonological system. Thus when some segments have to be registered in violation of native rules, the borrower will change his inadmissible underlying representations to admissible ones sooner or later, unless he learns to revise the native system to allow them. In other words, the inadmissible forms which were first registered in the lexicon will be changed to admissible ones by the application of the dominant rules which constrain them--a process I refer to as the 'restructuring of underlying representations'.

In summary, foreign segments will be put in the lexicon as they are on the surface unless they are inadmissible underlying segments. If they are inadmissible, they will be analyzed by the native rules until some admissible representation is obtained. If a segment cannot be analyzed as an admissible form in the native system, it will be represented in the lexicon as it is and finally will be restructured by the dominant native rules.

1.3. Re-examination of Hyman's data

Let us re-examine some of the Nupe data under the new hypotheses. The foreign phonetic sequence si which Hyman gives to exemplify his principle 1 will be put in the lexicon as it is, according to our principle, since it is an admissible underlying sequence of Nupe. Consequently it becomes subject to the phonological rules of Nupe, and will be realized as ʃi by the application of the Nupe spirant palatalization rule and the general assimilation rule.

The next problem concerns an epenthetic vowel, for which there are at least two possible explanations. First, suppose that the fact that Nupe doesn't have consonant clusters is explained by an epenthesis rule of the form CC → CVC, and that Nupe doesn't have a rule which derives superficial CC. Then CC in foreign words will be put in the lexicon as such, in violation of the rule CC → CVC, because CC cannot be analyzed as an admissible sequence in the native system. In the realization of this CC, the rule CC → CVC will apply and create CVC. The epenthetic vowel is subject to the other constraints Hyman discusses.

A second explanation is possible. Suppose that Nupe morpheme structure is constrained by a rule like CC → C, and that Nupe has a rule CVC → CC, dominated by the former rule. The latter rule might not appear at the normal speed of speech, but (according to Stampe) it is a quite common rule in fast speech, so that it would be plausible for Nupe to have such a fast speech rule. Then CC would be analyzed as admissible CVC. Whatever the case is, there is an explanation for the fact that consonant clusters are broken up by vowels, rather than in some other way. We need more facts about Nupe phonology to determine exactly what is going on here, of course.

One of the facts which leads Hyman to set up principle 3 is the substitution of vowels after labialized and palatalized

consonants in some loan words; there, Nupe speakers change unrounded front vowels into rounded back ones after labialized consonants, and rounded back ones into unrounded front ones after palatalized consonants. Nupe has an assimilation rule of the form:

$$[+\text{cons}] \rightarrow \begin{bmatrix} +\text{high} \\ \alpha\text{round} \\ \beta\text{back} \end{bmatrix} / __ \begin{bmatrix} \text{V} \\ \alpha\text{round} \\ \beta\text{back} \end{bmatrix}$$

But this assimilation rule doesn't apply to a foreign sequence like śu; rather, the vowel u in it is converted into i, so that ś is derived in an appropriate environment by the assimilation rule. Thus, Hyman concludes that a principle like 3 is necessary. What he assumes here is that Nupe has a consonant assimilation rule but not a rule assimilating features of a vowel to those of a preceding consonant. But it is possible to assume that Nupe has such a rule, for there are other languages which have this rule and there is no reason why Nupe speakers cannot employ it. We merely cannot observe it normally, since it is ordered before the consonant assimilation rule, and since the palatalized and labialized consonants arise only by the consonant assimilation rule. If we assume that Nupe has such a vowel assimilation rule (VAR), and a depatalization-delabialization rule (DR) which prohibits underlying palatalized and labialized consonants, then the borrowing of śu will be explained as follows: śu will be put in the lexicon in violation of VAR and DR. VAR and DR apply to it in this order to derive si. That is, si is the restructured underlying representation. The spirant palatalization and general assimilation rule apply to it in the process of derivation, and it will be realized as $\acute{s}^{y}$i. I show the process of analysis and realization in the diagram below. The upward arrow indicates an analysis of foreign segments as native underlying representation (including a direct transfer of foreign phonetic representation) and the downward arrow the realization process in the native system.

[śu] ↑ /śu/ ↓ /śi/ ↓ /si/ ↓ śi ↓ [$\acute{s}^{y}$i]

VAR DR — restructuring of the underlying representation

spirant palatalization

general assimilation

In the following section, I will discuss some English loan words in Japanese according to the above principles of borrowing, as a further validation of them.

2. English loan words in Japanese

In addition to numerous Chinese loan words, Japanese has borrowed many words from Western languages--English, German, French, Dutch, Italian and Russian. Modern Japanese is especially full of English loan words, which sometimes make language purists frown.

In this section I examine some English loans in Japanese to see whether the hypotheses in the previous section give a correct account of the actual borrowing process. And at the same time I discuss some properties of the system of Japanese phonology which are revealed in the process of borrowing. All the rules will be presented quite informally.

2.1. Palatalization

In Japanese, consonants are palatalized before the high front vowel i or the high front glide y. This is expressed by the following rule:

1. Palatalization

$$C \rightarrow [+pal] \; / \; __ \begin{bmatrix} -cons \\ +high \\ -back \end{bmatrix}$$

Since all superficially palatalized consonants can be derived by rule 1, we can assume that Japanese has, ordered before rule 1, a rule which depalatalized underlying consonants:

2. Depalatalization

$$C \rightarrow [-pal]$$

Rule 2 does not manifest itself in substitutions; it merely requires underlying consonants to be nonpalatal. The glide y is lost after superficially palatalized consonants.

3. y-loss

$$y \rightarrow \emptyset \; / \; \begin{bmatrix} C \\ +pal \end{bmatrix} __$$

Rule 3 merely supplies phonetic detail, but it will be crucial to my account of certain borrowings. I examine first how the English palatalized velar stops ḱ and ǵ are borrowed into Japanese.

In English, ḱ and ǵ are derived from k and g respectively by the process of palatalization before and after the front vowels (Bach 1968, 128-9). When velars occur between two vowels, the second vowel determines their value; consequently ḱ and ǵ don't occur before a nonfront vowel even if they are preceded by a front vowel (instead k and g occur there). Thus palatalized velars occur in such words as [ḱip] 'keep', [ḰIḰ] 'kick', [ḱeyḰ] 'cake', [tIḰt] 'ticket', [ḱændi] 'candy', [ǵIft] 'gift', [bowǵi] 'bogie', [ǵeym] 'game',

[ǵɛst] 'guest', [ǵæp] 'gap'. I will discuss in this section only how the palatalized velar stops followed by front vowels are borrowed, leaving those preceded by front vowels to the section on vowel insertion.

ḱ or ǵ followed by the high front vowel in such words as [ḱip, ḰIḰ, bowǵi, ǴIft] will be interpreted as underlying k and g by undoing rule 1, in order to eliminate the palatalized consonants which are banned by rule 2. Since the ki and gi are admissible, they are not subject to further analysis. They will be represented as such in the lexicon and realized as ḱi and ǵi phonetically by the application of rule 1. The analysis and realization of these consonants thus exactly parallels that of native words like [ḱinu], underlying /kinu/ 'silk' and [ǵimu], underlying /gimu/ 'duty'.

Palatalized velars before a nonhigh front vowel cannot be analyzed as nonpalatal by rule 1 because it applies only before high front vowels. This would require such consonants to be registered as underlyingly palatal, in violation of rule 2. However, rule 3 furnishes a way of avoiding this. By rule 3 a sequence such as ḰE, where E is a nonhigh front vowel, can be analyzed as ḰyE, thus furnishing the high front segment which permits further analysis as KyE by rule 1. Thus such sequences as ḱæ and ǵæ will be analyzed as ḱyæ and ǵyæ by rule 3, and further as kyæ and gyæ by rule 1. æ in kyæ and gyæ will be replaced by rules determining the vowel system of Japanese.[3] The following diagram shows the process of borrowing and realization of ḱæ and ǵæ.

[ḱæ]	→	ḱyæ	→	/kyæ/	→	/kya/	→	ḱya	→	[ḱa]
[ǵæ]	→	ǵyæ	→	/gyæ/	→	/gya/	→	ǵya	→	[ǵa]
		3		1				1		3

Examples:[4]

English		Japanese
[ḱændi]	'candy'	[ḱandii]
[ḱæp]	'cap'	[ḱappɯ]
[ǵæp]	'gap'	[ǵappɯ]
[ǵæǵ]	'gag'	[ǵagu]

As described above, ḱæ and ǵæ in many words come out as ḱa and ǵa in Japanese, but there are also numerous words where they come out as ka and ga, with plain stops, as in the following examples:

English		Japanese
[ḱælənd$^{\partial}$]	'calendar'	[karendaa]
[ḱætəlɔg]	'catalog'	[katarogu]
[ǵæs]	'gas'	[gasɯ]
[ǵælən]	'gallon'	[garoN][5]

I think this is because the palatality of the velar stops before e in English is relatively weak and sometimes is not perceived by speakers of Japanese, who consequently represent the stops as underlying k and g, without the analysis described above.[6]

To account for the borrowing of ḱe and ǵe, we have to take into consideration a rule of Glide Deletion in Japanese.

4. Glide deletion

$$\begin{bmatrix} \text{G} \\ \alpha\text{back} \end{bmatrix} \rightarrow \emptyset \; / \; __ \; \begin{bmatrix} \text{V} \\ \alpha\text{back} \\ -\text{low} \end{bmatrix}$$

That is, y is deleted before the nonlow front vowels i and e, and w before the back nonlow vowels u and o. This rule constrains underlying representation, so that there can be no underlying ye vs. e. ḱe and ǵe can be analyzed as ḱye and ǵye by rule 3 and then as kye and gye by rule 1, thereby conforming to the prohibition against palatalized consonants (rule 2). But kye and gye violate the prohibition against underlying ye imposed by rule 4. The English sequences ḱe and ǵe cannot be analyzed, therefore, as any representation which is admissible in the Japanese system. If they are registered as kye and gye, rule 4 is violated; if as ḱe and ǵe, rule 2 is violated. In either treatment, the sequences will be pronounced as ke and ge:

/kye/	→(4)	/ke/	→	[ke]	/gye/	→(4)	/ge/	→ [ge]
/ḱe/	→(2)	/ke/	→	[ke]	/ǵe/	→(2)	/ge/	→ [ge]

The learner's representation will thus be restructured to ke and ge, unless he learns to manage the foreign sounds by changing the native system in some way. The following examples confirm the above discussion.

English		Japanese
[tIḱɛt]	'ticket'	[čiketto]
[ḱeyḱ]	'cake'	[keeḱi]
[ǵɛst]	'guest'	[gesuto]
[ǵeym]	'game'	[geemu]

Next I discuss how the English alveopalatal obstruents š, č, ǰ are borrowed.

The voiced sibilant z in Japanese has the tendency to be affricated. For some speakers z and dz are in free variation, and for others they are in complementary distribution. Mieko Han reports on her own speech, where dz occurs word initially and z in other positions (Han, 50). The palatalized voiced sibilant, ź, on the other hand, is affricated everywhere, though the unaffricated ź might appear occasionally in very limited environments. The affrication of the voiced sibilant in the same dialect as Han's could be formulated as follows:

5. Affrication of the voiced sibilant

$$\begin{bmatrix} -\text{son} \\ +\text{cont} \\ +\text{voi} \\ \langle -\text{pal} \rangle \end{bmatrix} \rightarrow [+\text{del rel}] \; / \; \langle \# __ \rangle$$

The coronal stops t and d are affricated before the high vowels, i and u, and the glide y.

6. Affrication of coronal stops

$$\begin{bmatrix} -\text{son} \\ -\text{cont} \\ +\text{cor} \end{bmatrix} \rightarrow [+\text{del rel}] \; / \; __ \begin{bmatrix} -\text{cons} \\ +\text{high} \end{bmatrix}$$

This means that the opposition between z and d neutralizes in certain environments.

The derived (i.e. systematic phonetic) ś, ʣ, and ʦ are phonetically more like the alveopalatal obstruents [š], [ǰ], [č] than like the palatalized alveolar obstruents [ś], [ʣ], [ʦ]. The points of articulation of these segments are in the prepalatal region. Hence I propose rule 7, which converts ś, ʣ and ʦ into š, ǰ and č, respectively. This rule merely supplies phonetic detail, but it plays a role in borrowing the š, č and ǰ of English.

7. $\begin{Bmatrix} \acute{s} \\ \acute{dz} \\ \acute{ts} \end{Bmatrix} \rightarrow \begin{Bmatrix} \check{s} \\ \check{j} \\ \check{c} \end{Bmatrix}$

English ši will be interpreted as śi by rule 7, hence as underlying si by rule 1. It will be realized as ši by the application of these rules. či will be analyzed as ʦi by rule 7, further as ti by rule 6 and rule 1; it will be realized as či by the application of these rules.

There are two possible interpretations for ǰi, shown in the following diagram:

(A)	[ǰi]	→	ʣi	→	źi	→	/zi/	→	ži	→	ʣi	→ [ǰi]
		7		5		1		5		7		
(B)	[ǰi]	→	ʣi	→	ʤi	→	/di/	→	ʤi	→	ʣi	→ [ǰi]
		7		6		1		1		6		7

(In case (B), ʣi could first be depalatalized (rule 1) and then deaffricated (rule 6), since the palatalization and the affrication of coronal stops are not in an ordering relation, but there is no difference in the resultant form.) There is no empirical evidence as to whether the underlying form of ǰi is /zi/ or /di/, since in either case the superficial form is [ǰi].

The remarks appropriate to ǩe and ǧe should apply to še, če and ǰe as well. That is, we expect them to be depalatalized as se, te, and ze or de, respectively. But, unlike ǩe and ǧe, they are not completely nativized in many cases; the palatality of the consonants before e is kept here against the native rule. The problem of what kind of native rules are easily modified in borrowing is an interesting one, but it is not in the scope of this paper. I couldn't find any example where če is completely nativized as te, but I have some examples where še and ǰe are completely nativized. I consider ǰe here, since there are two possibilities in nativization, namely ze and de.

After analysis by rule 7 as ǰze, ǰe could be registered either as /ǰe/ or /źe/ in violation of rule 2, or /dye/ or /zye/ in violation of rule 4. Let us examine the latter cases first.

(C)	[ǰe]	→	ǰze	→	źe	→	źye	→	/zye/	→	/ze/	→ [dze]
		7		5		4		1		4		5
(D)	[ǰe]	→	ǰze	→	ǰe	→	ǰye	→	/dye/	→	/de/	→ [de]
		7		6		4		1		4		

The y-insertion might apply before deaffrication in analysis, since they are not in an ordering relation, but the resulting underlying forms would be the same. The phonetic outcome [dze] of (C) appears usually word-initially in the dialect with which I am concerned. Now the data show that the analysis (C) is actually employed by Japanese.

English		Japanese
[ǰelətɨn]	'gelatin'	[dzeračin]
[ǰeli]	'jelly'	→ [dzerii]
[ǰesčɨ]	'gesture'	→ [dzesčaa]

This might be because dze is phonetically closer to ǰe than de is, being different from it only by one feature, namely [+anterior], but from de by two, [+anterior] and [-delayed release]. Or it might be because the affrication of the coronal stops is ordered before the affrication of the voiced sibilant though this ordering doesn't manifest itself in the native system. Then the analysis would be the reverse of the order for generation, dze analyzed as ze rather than de. But at present I have no independent support for this ordering.

There is one fact in dialects of Japanese which suggests that ǰe is more closely related to ze than to de. There are some dialects in Kyuusyuu where the sibilants, s and z are palatalized not only before i and y but also before e. That is, they are palatalized before front vowels and a glide. But this palatalization before e

doesn't affect the dental stops, t and d. This means we have ʒe (and often ǰe as a free variant) in these dialects for ze (dze) in the Tookyoo dialect and suggests a close relation between ǰe and ze (rather than de). And as I mention in footnote 7, Japanese spirants might have developed from affricates historically.

Let us consider next whether we can get the same result if ǰe is registered as de or ze in violation of rule 2.

(E)	[ǰe]	+	dze	+	/ʑe/	+	/ze/	+	[dze]
			7		5		1		5
(F)	[ǰe]	+	dze	+	/de/	+	/de/	+	[de]
			7		6		1		

The adoption of the analysis (E) can be explained as above.

ša, šo, šu, ča, čo, ču, ǰa, ǰo and ǰu will be analyzed as sya, syo, etc., with y in the underlying representation, as in kæ and gæ. Some examples:

English		Japanese
[ša:p]	'sharp'	[šaapɴ]
[šat]	'shot'	[šotto]
[šut]	'shoot'	[šuuto]
[ča:tɚ]	'charter'	[čaataa]
[čɔk]	'chalk'	[čookɴ]
[čuIŋ gʌm]	'chewing gum'	[čuuiŋgamu]
[ǰʌmp]	'jump'	[ǰampɴ]
[ǰowk]	'joke'	[ǰookɴ]
[ǰus]	'juice'	[ǰuusɴ]

2.2. Vowel insertion

McCawley (1968, 131-4) has claimed that standard Japanese is a mora-counting syllable language, in which the syllable functions as the prosodic unit and the mora as the unit of phonological distance. A mora consists of a consonant plus a vowel, a glide plus a vowel, a vowel alone, a mora nasal, or a mora obstruent,[8] so that [kii] 'key', [peN] 'pen', [yotto] 'yacht' are respectively two, two and three moras. Among these moras, the mora nasal and the mora obstruent don't constitute syllables, but rather each constitutes a syllable with a preceding mora. Thus [peN] 'pen' and [yotto] 'yacht' have respectively one and two syllables. A long vowel which is phonologically two identical short vowels also counts as one syllable, as does a diphthong (although both of them are two moras), so that [kii] 'key' and [tai] 'tie' are both one-syllable words.

There are constraints on the distribution of some of the syllables. The syllable (C)VC, where the last C is the mora obstruent, cannot

occur word-finally. Moreover, the syllable which follows must begin with the same obstruent as the mora obstruent. Thus, there are only two kinds of consonant clusters in Japanese, namely the cluster of two identical voiceless obstruents (pp, tt, kk, ss) and of the mora nasal plus a consonant.

The above facts about syllable structure will be described by the following set of rules:

8. $CC \rightarrow C / [.]^{*9}$

9. $C \rightarrow [-son] / ___.$

10. $\begin{bmatrix} -son \\ +voi \end{bmatrix} \rightarrow [+nas] / ___.$

11. $[+nas] \rightarrow [+son]$

12. $C \rightarrow [-son] / [-son] ___$

13. $\begin{bmatrix} C \\ <-son> \end{bmatrix} \rightarrow \begin{bmatrix} \alpha ant \\ \beta cor \\ <\gamma cont> \end{bmatrix} / __ \begin{bmatrix} C \\ \alpha ant \\ \beta cor \\ <\gamma cont> \end{bmatrix}$

14. $C \rightarrow \emptyset / ___\#$

Rule 8 says that there is no consonant cluster before or after the syllable boundary. Rules 9 and 10 state that a syllable-final consonant is an obstruent and that a voiced obstruent becomes nasal in this position.[10] Rule 11 changes the nasal obstruent into a sonorant. That the mora nasal thus generated is homogranic with the following consonant is stated by rule 13. Rules 12 and 13 insure that a syllable-final voiceless obstruent is identical to the following obstruent. Rule 14 says that there is no word-final consonant.

Now I examine what processes apply to a consonant cluster or a word-final consonant of English in borrowing. If there were no rule which derived a syllable-final consonant and which was dominated by rules 8 through 14, then medial consonant clusters would be simplified by 8, after which there would be nasalization and assimilation by 9 through 13, and a word-final consonant would be deleted by 14. But Japanese has a so-called 'devoicing' rule, which provides Japanese speakers with the way to cope with numerous consonant clusters or word-final consonants in English.

The phenomenon of vowel devoicing in Japanese is quite complicated, and an exact description has not been worked out yet. The following devoicing rule is given by McCawley (127) as an approximation.

15. Devoicing

$$\begin{bmatrix} V \\ +\text{high} \end{bmatrix} \rightarrow [-\text{voi}] \,/\, [-\text{voi}] __ \left\{ \begin{matrix} [-\text{voi}] \\ \# \end{matrix} \right\}$$

That is, the high vowels are devoiced between voiceless consonants or between a voiceless consonant and a word boundary. The above rule does not express the fact that when several consecutive syllables each contain a high short vowel between voiceless consonants, only alternate vowels become voiceless, the choice of the syllables to be devoiced depending on several factors (such as the particular vowels affected, the consonants of the environment, and the pitch of the syllable). Devoicability also varies with the speed of speech. According to an acoustic study by Mieko Han (1962, 20) only the high vowels i and u are devoiced at the normal speed of speech, as in McCawley's formulation. The other vowels are often weakened under certain circumstances but, they are usually not devoiced at 'normal speaking tempo'. Han's experiment doesn't treat fast speech extensively, but at one point she mentions that such a sequence as /susuki/ 'Japanese pampas grass' is reduced to [s:s:ki] or even [s::ki] and /huhuku/ 'discontent' to [h:h:ku] or even to [h::ku] in fast speech.[11] That is, the high vowels are actually deleted, rather than merely devoiced, under certain conditions. Among the consonants, fricatives show the greatest effect on devoicing, then affricates and finally stops. Since a vowel is inserted in borrowing where there is none in the original word, a stronger form of rule 15, that is, a rule of deletion rather than just devoicing, is the one I consider to be reversed. I assume the following fast speech rule is used to analyze borrowed words which have consonant clusters or word-final consonants.[12]

16. Deletion of high vowels (fast speech)

$$\begin{bmatrix} V \\ +\text{high} \end{bmatrix} \rightarrow \emptyset \,/\, [-\text{voi}] __ \left\{ \begin{matrix} [-\text{voi}] \\ \# \end{matrix} \right\}$$

The high vowels are usually devoiced or deleted only between voiceless obstruents or a voiceless obstruent and a word boundary, but the insertion is carried on after voiced consonants, too. Hence I will suppose that rule 16 is expanded to the environment of voiced consonants in borrowing.

The next problem concerns which of the two high vowels i and u is chosen as the epenthetic vowel. Here we notice that the environments of devoicing for these two vowels are not actually the same, because palatalization precedes devoicing; we have [kíša] 'train', [šíka] 'deer', etc., but not [kíša] or [síka]. That is, the consonant before i which is subject to devoicing is always palatalized. Thus rule 16 can be decomposed as follows:

16. a. $\begin{bmatrix} V \\ +high \\ -back \end{bmatrix} \rightarrow \emptyset \; / \; \begin{bmatrix} -voi \\ +pal \end{bmatrix} __ \begin{Bmatrix} [-voi] \\ \# \end{Bmatrix}$

b. $\begin{bmatrix} V \\ +high \\ +back \end{bmatrix} \rightarrow \emptyset \; / \; [-voi] __ \begin{Bmatrix} [-voi] \\ \# \end{Bmatrix}$

u can occur after both palatalized and plain consonants, since y-loss (rule 3) precedes devoicing. For example, we get [sʸsoo] 'prime minister' from the underlying /syusyoo/ by the application of palatalization, y-loss and devoicing, in this order. Because of the nature of rule 16 discussed above, when the consonant after which a vowel is to be inserted is not palatalized or palatal, rule 16a cannot be used, since its environment is inappropriate; then 16b will be reversed, and we get an epenthetic u. Some examples:

English		Japanese
[sup]	'soup'	[suupᵘ]
[plat]	'plot'	[purotto]
[klʌb]	'club'	[kurabu]
[blu]	'blue'	[buruu]
[fɔrk]	'fork'	[ɸookᵘ]
[krim]	'cream'	[kuɾiimu]
[gæg]	'gag'	[gagu]
[grIl]	'grill'	[guriru]
[nayf]	'knife'	[naiɸᵘ]
[seyf]	'safe'	[seeɸᵘ]
[stowv]	'stove'	[sᵘtoobu]
[kɝv]	'curve'	[kaabu]
[bæθ]	'bath'	[basᵘ]
[θrIl]	'thrill'	[suɾiru]
[blaws]	'blouse'	[burausᵘ]
[towstɚ]	'toaster'	[toosᵘtaa]
[čiz]	'cheese'	[čiizu]
[kæš]	'cash'	[kassᵘ]
[hæm]	'ham'	[hamu]
[mIlk]	'milk'	[mirukᵘ]

After the palatalized or palatal consonants, either u or i could be inserted, since both can occur in this environment. But there is some phonetic difference between the palatalized consonant before i and the one before u which doesn't allow an arbitrary choice between them. I will refer to the one before i as bright and the one before u as dark, though there might be a better term to characterize this difference. The palatalized consonants before a and o have the same quality as the one before u. I suppose that Japanese has a low-

level phonetic rule that darkens the palatalized consonants before back vowels. This difference is important, since Japanese speakers don't confuse [sʲsoo] 'obstacle' and [sʷsoo] 'prime minister' even when the vowel in the first syllable is devoiced or virtually deleted. The same phonetic difference exists between kʲu, pʲu, cʲu and kʲi, pʲi, cʲi respectively. In the case of the palatalized velars and palatal affricates, those before i are phonetically closer to the corresponding English sounds, while in the case of the palatal spirants, those before u are closer. Thus i is inserted in the former environment and u in the latter.

English		Japanese
[dæʃ]	'dash'	[dasshʲi]
[kæʃ]	'cash'	[kasshʲi]
[frɛʃ]	'fresh'	[ɸuresshʲi]
[mæʧ]	'match'	[macchʲi]
[pɪnʧ]	'pinch'	[pʲiɲchʲi]
[tʌʧ]	'touch'	[tacchʲi]
[sɔsɪʤ]	'sausage'	[sooseejʲi]
[peyʤ]	'page'	[peejʲi]
[spʌnʤ]	'sponge'	[sʷpoɲjʲi]
[kʲeyk]	'cake'	[keekʲi]
[strayk]	'strike'	[sutoraikʲi]
[breyk]	'brake'	[bureekʲi]

One further point about the palatalized velars: the data show that after the palatalized velars either u or i is inserted. When u is inserted the palatality of the velar stops in the original English word is not carried over to Japanese. That is, a plain velar is substituted for the palatalized one. As I mentioned in section 2.1, the palatality of the palatalized velars before the low front vowel is sometimes neglected in borrowing; because of the subtlety of the palatalization in this environment, Japanese speakers often perceive fronted stops as plain velars. The same situation happens here. The palatalization of the velar stops in English is a mirror-image rule. Bach has pointed out that in a mirror-image rule the influence of the following segment is stronger than that of the preceding one. In particular, a velar which <u>follows</u> a front vowel is more weakly palatalized than a velar which <u>precedes</u> a front vowel; and it may be that Japanese speakers often do not perceive the weaker palatality of the velar position after a front vowel. When they miss the palatality of a velar, they insert u, and when they perceive it, they insert i. The following list illustrates insertion of u after palatalized velars (with consequent loss of palatality):

English		Japanese
[kʲɪkʲ]	'kick'	[kʲikkʲi]
[tiːkʲ]	'teak'	[cʲiikʲi]
[pækʲ]	'pack'	[pakkʲi]

English		Japanese
[bIǵ liǵ]	'big league'	[b̀iggu ĺiigu]
[bæǵ]	'bag'	[baggu]
[pIḱnIḱ]	'picnic'	[ṕikuńikkń]

The vowel after t and d must be mentioned next. Here neither i nor u, but rather o, is usually inserted. The underlying t and d are affricated before u and are both palatalized and affricated before i in Japanese. The choice of o after them, therefore, seems designed to keep the processes of affrication and palatalization from applying to them. Thus, the weaker version of Hyman's third principle seems to be necessary. This principle predicts a change in the environment of a segment so that it will be derived in an environment appropriate for the borrowing language. It was pointed out in section 1.1 that this principle is too powerful, in that it allows more than one substitution in the environment. But in the present case, the epenthetic vowel is chosen so that some processes will not apply to the preceding consonant and so that the quality of the consonant will be kept as close as possible to the original one. So I admit that something like Hyman's third principle is necessary in such cases, where new segments are created rather than substitutions made for existing segments. Why o rather than e or a is chosen still needs explanation.

Mieko Han's experiment shows that the u is more readily devoiced than i in the same environment. This correlates with the fact that u is inherently shorter than i in Japanese (Han, 23). Her investigation also shows that o is the third shortest vowel, following u and i. If it is the case that the shorter a vowel is, the easier it is for it to be devoiced or deleted, then o would follow u and i in its ability to be devoiced. It is usually the high vowels that are devoiced, but o could be devoiced in fast speech. And it would be devoiced more easily than e or a. Following are some examples with o inserted after t and d.[14]

English		Japanese
[hIt]	'hit'	[ńitto]
[bɛlt]	'belt'	[beruto]
[strɔ]	'straw'	[sṵtoroo]
[strayk]	'strike'	[sṵtoraikń]
[bænd]	'band'	[bando]
[bɛd]	'bed'	[beddo]
[drIŋk]	'drink'	[dóiŋkń]
[drIbl]	'dribble'	[dóibiburu]

Finally, I would like to make one comment on the relation between devoicing and accent. The accented syllable is usually not devoiced (Han, 25) (that is, not deleted in fast speech).[15] The loan words are generally accented on the syllable containing the third-from-last mora (Josephs 1970).[16] When this syllable contains the vowel inserted

in the process of borrowing, the accent is often moved one mora to the left.

English		Japanese
[eprən]	'apron'	epūroN → [ēpuroN]
[dʌbl̩s]	'doubles'	dabūrusu → [dāburusu]
[sIlv^{ə}]	'silver'	sirūbaa → [s̆irubaa]
[pæstɛl]	'pastel'	pasūteru → [pāsuteru]
[fIkʃən]	'fiction'	ɸikūsoN → [ɸīkuso̞N]
[bIznIs]	'business'	bijīnesu → [bīj̆inesu]

Thus, with regard to accent, the epenthetic vowel is placed in the most favorable environment for deletion by rule 16.

2.3. Gemination of consonants

In adopting words with a consonant cluster or a word-final consonant, the gemination of a consonant is observed in certain cases in addition to the vowel insertion. That is, such English words as [tIp] 'tip', [hIt] 'hit' and [kIk] 'kick' come out as [c̆ippu], [ɲitto] and [kikku], respectively.

In English both the short vowel and the following consonant of word-final stressed syllables are considerably lengthened, and this lengthening of the consonant is especially conspicuous when it is released (the word-final consonant is usually unreleased, but it could be released in careful speech).[18] Thus [tIp] and [hIt], for example, are pronounced as [c̆Ip:'] and [kIk:'], respectively, in careful speech.[19] I assume that these are the forms that were borrowed into Japanese.

In Japanese the first consonant of a geminate (that is, the syllable-final obstruent) is characteristically unreleased. CC is phonetically a long C. The first consonant is released in the other environments, so [c̆ippu] 'tip' is pronounced [c̆ip:'] after the final vowel is devoiced, or rather deleted. This phonetic output is very close to the original English form.

One fact which supports the above explanation of geminates is that the final consonant preceded by a long vowel or a diphthong, which is not lengthened in English, is not geminated when borrowed into Japanese. The argument is not very strong, however, since this fact could also be explained by the condition on Japanese morpheme structure that VV cannot be followed by CC.

If Japanese speakers borrow some English words from casual speech, where the word-final consonants are unreleased, they might not perceive the existence of the final consonant and would probably delete them (this may be more true for voiceless obstruents than voiced ones). We have some loans which suggest that this situation has actually happened:

[hwaɪt ʃɚt]	'white shirt'	[waiʃatsu]
[ɔtowbayk]	'autobike'	[ootobai]
[kæbənɪt]	'cabinet'	[kabine]

Voiced obstruents are sometimes geminated and sometimes are not.

[bɪg]	'big'	[bigguɯ]
[bɛd]	'bed'	[beddo]
[gæg]	'gag'	[gaguɯ]
[klʌb]	'club'	[kurabu]

We also have a couple of examples where a voiced obstruent is geminated and then devoiced.

[hænd bæg]	'hand bag'	[handobakku]
[bʊlɖɔg]	'bulldog'	[burudokku]
[bɛd]	'bed'	[betto]

These forms all have doublets with voiced obstruents. Since voiced geminates are inadmissible in Japanese, Japanese speakers have to revise the native system to allow voiced geminates; if they fail to do it, voiced geminates will either be degeminated or devoiced by the process of restructuring of inadmissible underlying representations.

What has been discussed so far can explain the gemination of final voiceless consonants (and the occasional gemination of voiced ones) in word-final stressed syllables, but not the gemination in unstressed or medial syllables.

The consonant might be lengthened even in final unstressed syllables, if speakers of English articulated it very carefully with release, so that foreigners could perceive it. But the medial consonants are usually not lengthened and in any event they would not need to be lengthened to be audible, because they are admissible in Japanese (or in any language). So gemination of medial consonants requires some other explanation.

What is peculiar about medial consonants is that they are sometimes geminated and sometimes not, as the following data show:

With gemination:

English		Japanese
[zɪpɚ]	'zipper'	[ʒippaa]
[flæpɚ]	'flapper'	[ɸurappaa]
[kʌtɚ]	'cutter'	[kattaa]
[ʃʌtɚ]	'shutter'	[ʃattaa]
[lʌki]	'lucky'	[rakkii]
[kʊki]	'cookie'	[kukkii]

Without gemination:

English		Japanese
[kapi]	'copy'	[kopii]
[pʌti]	'putty'	[pate]
[ʧIkIn]	'chicken'	[ʧikiɴ]

I have at the moment no clear idea of what distinguishes the two classes of loan words. Perhaps we have to consider the influence of spelling, which I totally neglected in this paper. All the examples I have found with the geminated medial consonant--except one (cookie)--have double letters (including ck for [k]) in English orthography. But the loans without the gemination of a medial consonant have either a single letter, as in copy, or doubled ones, as in putty. So we could say that if borrowing is strictly from hearing, the medial consonant would not be geminated, but that the borrowing of some words is influenced by this spelling with double letters. On the other hand, perhaps we shouldn't totally give up looking for a phonetic explanation; English-speaking children sometimes syllabify such words as batter and zipper (where a short vowel is followed by a short consonant) as bat.ter and zip.per. Further study of English phonetics might suggest some explanation for the way in which Japanese borrows such words.

The gemination of a word-final single consonant discussed before does not hold for s. As I mentioned in section 2.2, s constitutes the optimal environment for vowel devoicing in Japanese. The high vowels are usually deleted when they follow s and precede another voiceless consonant or word boundary, in fast speech and often even at the normal speed of speech. Han (43) mentions that when the final vowel is deleted, s is almost doubled in length. Thus the copula /desu/ comes out as [des:]. This phenomenon may provide some explanation for why Japanese doesn't have a contrast between /-ssu#/ and /-su#/: the phonetic difference between overlong [ss:] and merely long [s:] may be too subtle to allow differentiation of words. At any rate, when Japanese borrows words with -s#, phonetic similarity to English is guaranteed without gemination, since /-su#/ (after the nativizing vowel insertion discussed in 2.2) is realized as [s:] by vowel deletion plus the low-level process of s lengthening.

One fact about the sibilants which I can't explain is that a word-final s̆ is geminated, even though s isn't: [kæs̆s̆ɯ́] 'cash' and [pus̆s̆ɯ́] 'push'. Perhaps this has to do with the fact that s̆s̆ and s̆ contrast before a word-final high vowel, as in [is̆s̆í] 'one arrow' vs. [is̆í] 'doctor' and [is̆s̆ɯ́] 'one kind' vs. [is̆ɯ́] 'different kind', whereas plain ss and s do not contrast in this position.

Finally, I have a few comments on the word-final consonant clusters. When the first C of CC# is s, there is no gemination:

[tɛst]	'test'	[tesɯ́to]
[læst]	'last'	[rasɯ́to]
[dɛsk]	'desk'	[desɯ́ku]
[mæsk]	'mask'	[masɯ́ku]

This is presumably the same phenomenon as the failure of s to geminate discussed above. Contrast this case with that in which the C of a word-final sC cluster is a liquid or a nasal. Here s is geminated; since the inserted u is not devoiced in this environment, no 'compensatory lengthening' of s takes place.

English		Japanese
[hʌsl]	'hustle'	[hassuru]
[lɛsn]	'lesson'	[ressuɴ]

In the case of a stop followed by s, the stop is geminated. This could be explained in the same way as the gemination of a word-final single stop.

[čIps]	'chips'	[čippusɯ]
[sɑks]	'socks'	[sokkusɯ]
[mIks]	'mix'	[mikkusɯ]
[Indɛks]	'index'	[indekkusɯ]
[slæks]	'slacks'	[surakkusɯ]

What I cannot explain at present about word-final consonant clusters is that neither consonant is geminated when both of them are stops:

[tækt]	'tact'	[takuto]
[sɛkt]	'sect'	[sekuto]
[skrIpt]	'script'	[sukuriputo]

2.4. Glides

It is a well-known fact that the distribution of the glides w and y is quite limited in Japanese. w occurs only before a, and y only before u, o, and a. The restriction can be explained by postulating the following rules.

17. Glide deletion

$$\text{(A)}\quad G \rightarrow [\text{-back}] \;/\; __ \begin{bmatrix} V \\ \text{-back} \end{bmatrix}$$

$$\text{(B)}^{20}\quad \begin{bmatrix} G \\ \alpha\text{back} \end{bmatrix} \rightarrow \emptyset \;/\; __ \begin{bmatrix} V \\ \alpha\text{back} \\ \text{-low} \end{bmatrix}$$

That is, w becomes y before the front vowels, and then y is lost before i and e, and w before u and o.

Now I consider how an English sequence GV is treated when it is introduced into Japanese. Since the sequences wa, ya, yo, and yu are

admissible phonological representations, they will be registered in the lexicon as they are.

English		Japanese
[wat]	'watt'	[watto]
[ya:n]	'yarn'	[yaaN]
[yɔ:k]	'york'	[yookɯ]
[yuθ]	'youth'	[yuusɯ]

But since wi, we, wu, wo, yi, and ye are prohibited by rule 17, and since there is no rule which is dominated by 17 which can analyze these sequences, we assume that they are registered in the lexicon in violation of rule 17 and are realized as i, e, u, o, i and e, respectively, by the application of rule 17. But when we examine the loan words which originally had a GV sequence, we see that our prediction is not entirely correct:

[wIt]	'wit'	[uitto]
[wɛt]	'wet'	[uetto]
[wʊd]	'wood'	[uddo]
[wɔtɚ]	'water'	[uootaa]
[yɛlow]	'yellow'	[ieroo]
[wIŋk]	'wink'	[uiŋkɯ]
[weyv]	'wave'	[ueebu]
[wul]	'wool'	[uuru]
[wɔk]	'walk'	[uookɯ]
[yɛs]	'yes'	[iesɯ]
[yIr]	'year'	[iyaa]
[yist]	'yerst'	[iistɯto]

As we expected, y before i and w before u are lost. But y and w in the other environments are not deleted, but are instead vocalized as i and u, respectively. If our hypothesis is correct, there must be a rule in Japanese which derives w from u and y from i which can be used to analyze such sequences as wi, we, wo and ye and vocalize the glides in them. There is one other fact which suggests the existence of such a rule: there is a gap in the distribution of vowels, any sequence of two vowels being possible in a single morpheme, except *ia, *ea, *ua and *oa. This gap in distribution, which looks accidental at first glance, could be explained by postulating a rule that converts i and e into y, and u and o into w, before a. It also suggests an explanation for our present problem: that Japanese speakers reverse this rule by expanding its environment so as to vocalize the glides in wi, we, wo and ye. The choice of i and u rather than e and o could be explained by their closeness to y and w. But the problem still remains. I assumed that the analysis of inadmissible foreign forms was carried out only when there are some rules in the native system which generate them and which are dominated by the rules that prohibit them. But if there is a rule like

$$\begin{bmatrix} V \\ -low \end{bmatrix} \rightarrow [-syll] \; / \; __ \; \begin{bmatrix} V \\ +low \end{bmatrix}$$

it is a dominant rule which constrains the underlying representation. It is not dominated by any other rule. I cannot explain why this dominant rule should be reversed by expansion of its environment (even to a high vowel from a low vowel in case of wi) so as to vocalize the glides. Why doesn't rule 17 apply to them? The process of the vocalization of the glides in certain positions is a problem I must leave for further study.[21]

3. Concluding remarks

I have discussed how certain phonological processes of Japanese work in the analysis and realization of borrowed English words. The number of processes treated here is very limited: many others have been left for future study.

Phonological theory must provide an apparatus to describe the process of adopting foreign words, since they are treated with considerable uniformity when they are modified to conform to the native system. I consider ability to nativize loan words to constitute a part of linguistic competence.

Some of the results of this paper suggest that quite subtle phonetic facts may have to be considered to explain borrowing. One of the problems raised in a treatment of borrowing concerns perception. In this work, I have assumed that people can perceive any foreign sound, but I think this assumption is obviously wrong in certain cases. It is very difficult for native speakers of Japanese to hear the difference between the l and r of English, whereas they can hear the difference between θ and s, although it is hard for Japanese speakers to distinguish them in production. It seems to me that some rules control perception more than others, though I don't know how to characterize such rules at present. That the glides y and w are lost only before i and u respectively, but are vocalized in other positions, appears to have something to do with perception. Speaking impressionistically, it seems to be very difficult for Japanese to hear a y before i or a w before u. Japanese speakers can perceive the glides in other positions, though they can't always produce them correctly. Here we have a significant problem which needs much more research.

Footnotes

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1. Japanese has five vowels, characterized as follows:

	high	low	back
i	+	(-)	-
e	-	-	-
a	(-)	+	+
o	-	-	+
u	+	(-)	+

2. I will refer to a rule which generates a segment prohibited by a preceding rule as 'dominated' by the preceding rule. The analysis of underlyingly inadmissible foreign segments is carried out only when there is a rule available in the native system which generates them, and which is dominated by the rule which prohibits them.

3. Since Japanese has only five vowels (see fn. 2), each English vowel is replaced by one of them. As I am not talking about substitution for vowels in any detail, I list here typical substitutes which appear in examples in the body of the text. The process of vowel substitution will be omitted as long as it doesn't affect the discussion.

i	→	ii				u	→	uu
I	→	i				ʊ	→	u
e	→	e	ə	→	a	o	→	o
ɛ	→	e	ʌ	→	a			
æ	→	a	a	→	a	ɔ	→	o
				↘	aa		↘	oo

4. Disregard those segments in the examples which are not relevant to the present discussion. Some of them, such as vowels inserted word-finally and geminate consonants, will be discussed later. The slash over vowels denotes devoicing. Accent will not be indicated unless it is crucial to the discussion.

5. The capital N denotes a 'mora nasal', which sounds like a continuation of the preceding vowel before a vowel or in word-final position. In other positions its point of articulation is assimilated to the following consonant.

6. G. Drachman has pointed out to me that the velar stops are not palatalized before æ in British English; he suggests that words with plain velars before æ might have come in from British English. But there are some words which were obviously borrowed from American

English, like [gasorin] 'gasoline' where the velars are not palatalized in Japanese. There is still a possibility that such words were borrowed from a dialect in which the velars are not palatalized before s.

We can't neglect the possibility of spelling pronunciation of plain k and g in this environment, as Julie Lovins has pointed out to me.

7. I have one example provided by Julie Lovins, where če is nativized as se rather than te: [sero] 'cello'. I can't explain this in my present scheme, because there is no native rule which affricates a voiceless sibilant. But it is interesting when we look at the history of Japanese. Hideyo Arisaka (1957) has claimed that sibilants in Modern Japanese were affricates in eighth century Japanese. If his claim is valid, the ancient process is going on here.

8. The mora nasal is phonetically either a nasal or a nasalized segment colored by the surrounding segments. The mora obstruent is phonetically the gemination of the following obstruent. The voiceless obstruents that can constitute the mora obstruent are p, t, k and s.

9. . indicates a syllable boundary and * a mirror-image rule.

10. This rule shows up in the derivation of a class of verbs.

/yob-ta/	→	yob^{m}-ta	→	yom-ta	→ yonta → [yonda]
'call'					
'past'	10		11	13	

(The process of voicing assimilation which derives yonda from yonta is not discussed in this paper.) The interrelation of voiced obstruents and nasality is also observed in the Toohoku dialect where a word-medial voiced obstruent is prenasalized.

11. Notice here that the vowels of two successive syllables are deleted. This is observed only in the environment of fricatives.

12. It seems to me that so-called devoicing in Japanese could be considered deletion not just in fast speech, but generally. The basic phonetic difference between the result of devoicing and that of syncope seems to be not the existence of a vowel, but rather whether the consonant before a devoiced or syncopated vowel is released or not. That is, the consonant is released when the following vowel is devoiced, but it is not when the vowel is syncopated. And I assume, as I discuss later, that many words were borrowed from rather careful speech of English, where the final consonant is released. Thus the rule of devoicing, rather than syncope, is used to cope with the word-final consonant, the phonetic result of the former being closer to the original English sound, even though Japanese also has a rule of syncope.

The rule of syncope in Japanese deletes high vowels in certain environments (McCawley, 115-20). That is, the final high vowels of Sino-Japanese morphemes ending in -ki, -ku, -ti and -tu are lost in forming compounds when they are followed by: voiceless obstruents in the case of -ti and -tu, by another k in the case of -ki and -ku. Thus butu-situ 'substance' changes to butsitu (eventually to [bussitsɯ]) iti-pon 'one slender object' to itpon [ippon], gaku-koo 'school' to [gakkoo], etc.

The above discussion of the nature of devoicing is still speculative, and I assume here that the fast speech deletion rule is used to nativize consonant clusters or word-final consonants of English.

13. The high back vowel u in Japanese is phonetically somewhat centralized with very little lip rounding. It has a quality best transcribed as ɯ. Since the high central vowel ɨ in the Munda language Sora is also quite short (Stampe, personal communication), the fact that ɯ is shorter than i in Japanese may be related to its centralized quality and its lack of rounding.

14. There are a few words where u is inserted and t and d have undergone affrication:

[twIst]	'twist'	[tsuisɯto]
[sɛtlement]	'settlement'	[setsurumento]
[ʃɝt]	'shirt'	[satsɯ]
[kʌtlIt]	'cutlet'	[kacɯretsɯ]
[drɔ͡ɝz]	'drawers'	[dzuroosɯ]

15. The accented syllable is the syllable which contains the last high-pitched mora. Given its location, one can predict the pitch of all moras of the word. Cf. McCawley (133).

16. Josephs gives a number of rules which supplement the basic accentuation rule which places the accent on the third-from-last mora, but some of them could be explained by the fact that the mora which is created by the vowel insertion is not accented.

17. The macron indicates the accented syllable nucleus.

18. This account of English phonetics was provided me by Stampe.

19. : indicates lengthening of the preceding consonant and ' indicates release.

20. This is the same as rule 4 in section 2.1.

21. There is one interesting related fact about glides. All the GV combinations except wu and yi are attested at a stage in the history of Japanese. And all of them, again except wu and yi, still exist in some dialects (some dialects in Okinawa have wu and yi, but they are innovations from wo and ye). Notice that __u and __i are the environments where w and y, respectively, are lost in borrowing.

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